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ИЗГОТОВЛЕНИЕ ПРИСАДКИ ДЛЯ ПОДАЧИ ПРОВОЛОКИ НА МЕСТЕ ИЗ СПЛАВА Fe–Al ПУТЕМ ДОБАВЛЕНИЯ ХРОМА

Для изготовления железо-хром-алюминиевого сплава используется новое аддитивное производство проволоки, основанное на процессе сварки холодным металлом. В результате исследований было установлено, что увеличение содержания Al или уменьшение содержания Cr улучшает твердость сплава Fe–Cr–Al. Карбиды (Fe, Cr) xCy обладают способностью предотвращать образование трещин.

Ключевые слова: Производство добавок, CMT, сплав Fe–Cr–Al, растрескивание

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IN-SITU WIRE-FEED ADDITIVE MANUFACTURING OF FE-AL ALLOY BY ADDITION OF CHROMIUM

A new wire-arc additive manufacturing based on Cold Metal Transfer welding process is used to fabricate iron-chromium-aluminum alloy. From the research found that an increase in Al content or decrease in Cr content improved the hardness of the Fe–Cr–Al alloy. The (Fe, Cr)xCy carbides have the ability to prevent cracks.

Key words: Additive Manufacturing, CMT, Fe–Cr–Al alloy, Cracking

The Fe–Cr–Al alloy can form quasicrystal line phase and are known to present good high temperature oxidation resistance and corrosion resistance. Due to these properties, they find extensive application in solar energy absorbers, storage of hydrogen. There have been many research on Fe-Cr-Al alloy [1–4].

However, most of the current research is using vacuum induction melting (VIM) and arc melting to produce the Fe–Cr–Al alloy. The recent wire-arc welding based additive manufacturing technology, Increasingly used to make dissimilar alloys. In the present work, an innovative wire-arc additive manufacturing (WAAM) based on Cold Metal Transfer (CMT) welding process is proposed to fabricate iron-chromium-aluminum (Fe–Cr–Al) alloys, which employing feeding two wires separately into the molten pool.

Two wires are fed into a single molten pool under independent speed control. One of them is 1,2 mm diameter P91 wire which is fed by the CMT Advanced 4000R nc welder machine and another 1,2 mm diameter AlSi5-ER4043 wire is fed by WPC-600 multi-function argon arc welding wire feeder machine. After many trial experiments, the as-fabricated sample is made.

The first is to test the hardness of the sample. Test a hardness point every 2,5 mm. There is little change in hardness in the middle and top. Hardness fluctuates between 245 HV–286 HV. However, near the bottom, the hardness fluctuates significantly. The hardness of sample near the bottom is just about 180HV, which increases rapidly from 183 HV to 281 HV. The main reason is that the Al content in the dilution-affected zone is highly unstable, which leads to fluctuations of hardness correspondingly in the beginning. By contrasting Ejenstam research [5] found that a decrease in the Cr concentration led to increase in the hardness of the Fe–Cr–Al alloy.

Analyzed the metallographic structure of the sample and mechanical properties. Microstructures at higher magnification are captured taken from three typical regions: equiaxed grain region at the top, the columnar grain region at the middle and the dilution affected region at the bottom.

Some tensile tests show that the Ultimate Tensile Strength (UTS) of the sample is 552,78 ± 40,1 MPa. The 0,2% YS of the sample is 80,62 ± ± 4,04 MPa. The addition of Cr increases the room temperature elongation of the Fe–Al alloy. This is attributed to the fact that Cr atoms mainly replace the sub-nearest Fe atoms of Al atoms in the Fe3Al intermetallic compound sub-lattice of D03 structure.

The results of XRD phase characterization in the sample from crack, top, middle and bottom section was studied. There are Fe3Al, FeAl, Fe3C and Cr3C2 phases. However, there are no Fe3C and Cr3C2 phases both in the crack and bottom. The (Fe, Cr)xCy carbides have the ability to prevent cracks from occurring. The carbides are more effective in trapping free hydrogen. This improvement in cracking resistance is attributed to the hydrogen trapping potential of the carbide phases. Expecially In the middle section, the most obvious is the presence of (Cr, Fe)xCy carbides. The XRD results also indicate that the peak where FeAl is located is more intense in cracked areas than other areas without creak.

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